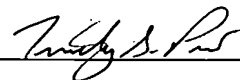


VERIFICATION OF TRANSLATION

I, Timothy S. Price, translator at Nakajima & Matsumura Patent Attorneys Office, 6F Yodogawa 5-Bankan, 3-2-1 Toyosaki, Kita-ku, Osaka, 531-0072, Japan, hereby declare that I am conversant with the English and Japanese languages and am a competent translator thereof. I further declare that to the best of my knowledge and belief the following is a true and correct translation made by me of Japanese Patent Application Publication No. H09-208851 filed on January 30, 1996.

Date: September 27, 2006

A handwritten signature in cursive script, appearing to read "Timothy S. Price", is written over a horizontal line.

Timothy S. Price

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(54) [TITLE OF THE INVENTION] PASTE FOR FORMING PROTECTIVE FILM  
20 FOR DIELECTRIC

(57) [ABSTRACT]

[PROBLEM TO BE SOLVED] To obtain a paste which is easy  
to handle and can form an MgO dielectric protective film having  
desired film strength and electrical properties in practical use  
25 in a plasma display panel.

[MEANS TO SOLVE THE PROBLEM] This paste is composed of  
MgO particles, an MgO precursor which forms an MgO binder when

baked, and an additive composed of organic substances, and the MgO precursor used is a combination of an organic acid magnesium with magnesium alkoxide.

5 [CLAIMS]

[CLAIM 1] A paste for forming a dielectric protective film, the paste comprising:

MgO particles;

an MgO precursor which forms an MgO binder when baked;

10 and

an additive formed from an organic substance, wherein the MgO precursor is a combination of an organic acid magnesium with 5 to 98 wt% inclusive of magnesium alkoxide.

15 [CLAIM 2] The paste for forming the dielectric protective film of Claim 1, wherein

the organic acid which constitutes the organic acid magnesium of the MgO precursor is one of a 7-12C aliphatic monocarboxylic acid and an alicyclic monocarboxylic acid.

20

[CLAIM 3] The paste for forming the dielectric protective film of Claim 1, wherein

the magnesium alkoxide of the MgO precursor is represented by the general formula  $(RO)_2Mg$ , R being one of methyl, ethyl and  
25 propyl.

[CLAIM 4] The paste for forming the dielectric protective

film of Claim 1, wherein

a purity of the MgO precursor is greater than or equal to 99.95% in terms of Mg.

5 [CLAIM 5] The paste for forming the dielectric protective film of Claim 1, wherein

a purity of the MgO particles is greater than or equal to 99.95%.

10 [CLAIM 6] The paste for forming the dielectric protective film of Claim 1, wherein

an average particle diameter of the MgO particles is 0.1  $\mu\text{m}$  with respect to 70 to 80 wt% inclusive, and 0.05  $\mu\text{m}$  with respect to 20-30 wt% inclusive.

15

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[FIELD OF THE INVENTION]

The present invention relates to a paste for forming a  
20 dielectric protective film of a plasma display panel by an application thermal decomposition method.

[0002]

[DESCRIPTION OF RELATED ART]

Conventionally, in alternating current plasma display  
25 panels (hereinafter, simply PDP), electrodes used for discharges are covered by a dielectric material, and moreover, a surface of the dielectric material is covered by a dielectric protective

film to prevent damage to the dielectric material from discharges.

[0003]

There is an application thermal decomposition method, which is a method for forming dielectric protective film using simple steps and without the need for complex and expensive apparatuses. For example, there are a number of proposals, such as: a paste for forming a transparent film, containing an alkaline earth metal compound that is soluble in an organic solvent (JP 58-135155,A); a method for forming a dielectric protective film, in which a protective film composed of a metal oxide is formed by applying and thermally decomposing an alkaline earth metal-containing organic compound on a dielectric material (JP 6-162920,A); a PDP panel in which a metal alkoxide such as Mg is applied and thermally decomposed on a dielectric layer, thereby covering the dielectric layer with a metal oxide protective film (JP 6-220372,A); a dielectric protective agent composed of alkaline metal oxide particles and a metal organic compound including Al, Si, Ti, Zr or the like (JP 6-316671,A); and a PDP in which the cathode and dielectric layer are covered by a metal organic protective film (JP 7-14516,A).

[0004]

A dielectric protective film composed of an alkaline earth metal oxide has an advantage of enabling an improvement in the panel properties of a PDP (e.g., lowering the discharge initializing voltage and the discharge sustaining voltage).

[0005]

[PROBLEMS SOLVED BY THE INVENTION]

However, in the above mentioned prior art, the metal alkoxide used in formation of the dielectric protective film readily turns into a gel, and gelates during the generation process of the metal alkoxide or during paste manufacturing, thereby making printing of the metal alkoxide difficult.

[0006]

Also, in the aforementioned prior art, the dielectric protective film readily detaches when it is formed with a film thickness of 0.5  $\mu\text{m}$  or more from an alkaline earth metal salt of an organic acid by one instance of printing and thermal decomposition. It is therefore necessary to reduce the film thickness of the dielectric protective film formed by one instance of printing and thermal decomposition to around 0.1 to 0.2  $\mu\text{m}$ , in order to avoid detaching. On the other hand, the ultimate film thickness of the dielectric protective film must be around 5 to 15  $\mu\text{m}$  in order to sufficiently function as a dielectric protective film. Therefore, there is an increased number of steps required to form a dielectric protective film with a desired film thickness in practical use.

[0007]

Here, a paste whose main components are an MgO powder, butyl carbitol, ethyl cellulose, etc. is used for forming, in fewer steps, a dielectric protective film that is easy to print and appropriate for practical use. A dielectric protective film formed from such a paste, however, has a high discharge initializing voltage and discharge sustaining voltage, which makes it difficult to obtain desired electrical properties in practical use.

[0008]

Also, although it is desirable for the organic acid constituting the organic acid magnesium that forms the MgO binder to have a low carbon number, the MgO film formed during application  
5 thermal decomposition will not adhere to the dielectric material if the organic acid has carbon number of six or lower.

[0009]

Moreover, if the organic acid magnesium that forms the MgO binder is used in the paste, the MgO film, which is the dielectric  
10 protective film formed by application thermal decomposition, will be too soft, and even a slight external force will easily cause damage.

[0010]

The present invention has been proposed in view of the  
15 current situation of the prior art, and aims to provide a paste which is easy to handle and can form an MgO dielectric protective film having desired film strength and electrical properties in practical use in a PDP.

[0011]

20 [MEANS TO SOLVE THE PROBLEMS]

As a result of assiduous investigation into a paste for forming a dielectric protective film, where the paste contains MgO particles, an MgO precursor which forms an MgO binder when baked, and an additive from organic substances, the inventors  
25 came to perfect the present invention by discovering the use of a combination of an organic acid magnesium with magnesium alkoxide, as the MgO precursor, in order to achieve the above aim. In other

words, the present invention is a paste for forming a dielectric protective film, the paste including: MgO particles; an MgO precursor which forms an MgO binder when baked; and an additive formed from an organic substance, wherein the MgO precursor is  
5 a combination of an organic acid magnesium with 5 to 98 wt% inclusive of magnesium alkoxide.

[0012]

According to the present invention, the MgO precursor and the additive are both organic materials, and organic components  
10 thereof are vaporized or thermally decomposed and dissipate into the atmosphere during application/drying of the paste or during baking. Therefore, the MgO precursor paste decomposes into Mg and the organic component during application/drying and baking, and the MgO forming the binder is generated by oxidization  
15 thereafter through the application of heat. This enables the formation of a dielectric protective film composed of MgO particles and an MgO binder, and given that MgO is the main component, this dielectric protective film is suitable for achieving desired properties in practical use in a PDP (e.g., electrical properties  
20 such as discharge initializing voltage, discharge sustaining voltage, or emission efficiency).

[0013]

Moreover, although it is possible to obtain a paste that resists gelation if only an organic acid magnesium is used as  
25 the MgO precursor in the present invention, the dielectric protective film formed by application thermal decomposition of the paste will be too soft due to the effect of the organic material



dissipating during vaporization or thermal decomposition, whereby a slight force will easily cause damage. On the other hand, if only Mg alkoxide is used as the MgO precursor, gelation will readily occur due to hydrolysis, and handling will be limited, but application thermal decomposition will form an MgO film that is hard and physically strong.

[0014]

Therefore, the aim of using a combination of an organic acid magnesium with Mg alkoxide as the MgO precursor, is to provide a paste that can be handled easily and can form a strong MgO film, since the organic acid magnesium forms an MgO protective film that resists gelation but lacks strength, and the Mg alkoxide forms an MgO film that is hard but readily gelates and is difficult to handle.

[0015]

Although the organic components such as the acyl included in the organic acid magnesium and the alkoxide included in the Mg alkoxide used in the present invention are not components necessary for the MgO film, these components are important for forming an even MgO precursor dry film during the application and drying steps of the MgO precursor paste. It is therefore desirable to completely dissipate these organic components into the atmosphere in the thermal decomposition step after forming the MgO precursor dry film. The organic acid magnesium used in the MgO precursor paste is therefore desirable since there are fewer organic components and a higher amount of Mg in the organic acid magnesium the smaller the molecular weight of the organic

acid is.

[0016]

The organic acid included in the organic acid Mg can be a single one of or a combination of two or more aliphatic series  
5 moncarboxylic acid with a carbon number of 7 to 12, such as a caproic acid, a caprylic acid, a capric acid, an octylic acid, a secanoic acid, a neo decanoic acid, neo oenanthic acid, neo nonoic acid, or an N-heptanoic acid. It is also possible to use a mixture of an acid with a carbon number of 6 or less (e.g.,  
10 an acetic acid or a propionic acid) with an acid with a carbon number of 7 or more. An Mg precursor paste using organic acid magnesium whose starting material is an organic acid composed of an acyl with a carbon number of 6 or less has a disadvantage in which the MgO film formed by application thermal decomposition  
15 resists adhering to the dielectric material, but on the other hand, since an organic acid magnesium whose starting material is an organic acid composed of an acyl with a carbon number of 12 or more is a powder, and has poor solubility in an organic solvent, using such an organic acid magnesium as the MgO precursor  
20 will not obtain an MgO protective film with satisfactory panel properties in a PDP.

[0017]

Next, if the organic acids included in the organic acid magnesium are alicyclic carboxylic acids such as a naphthenic  
25 acid, there will be lower amount of Mg and more organic components in the organic acid magnesium since these alicyclic carboxylic acids have a larger molecular weight than the aliphatic series

monocarboxylic acids with a carbon number of 7 to 12. Therefore, it is easy to obtain an even MgO film by baking if such organic acid magnesium is used as the Mg precursor, but the MgO film will be bulky and weak. For this reason, using a greater amount of Mg alkoxide in the present invention than in a case of using an aliphatic series monocarboxylic acid Mg with a carbon number of 7 to 12 enables the formation of an MgO film equivalent to the case of using an aliphatic series monocarboxylic acid Mg with a carbon number of 7 to 12.

10 [0018]

It is desirable for the mixture ratio of the organic acid magnesium to Mg alkoxide in the present invention to be 5 to 98 wt% of Mg alkoxide in terms of MgO, with respect to the organic acid magnesium, and when the Mg alkoxide is less than 5 wt% with respect to the organic acid Mg, the MgO film formed by applying and thermally decomposing the MgO precursor paste will be too soft, and for example, MgO powder would stick to one's finger if one were to rub the MgO film.

[0019]

20 On the other hand, it is necessary for the mixture ratio of organic acid magnesium to be 2 wt% or more with respect to Mg alkoxide, since it is impossible to overcome the ease of gelation when using solely Mg alkoxide as the MgO precursor if the mixture ratio is less than 2 wt%. Commercially available Mg alkoxide may be used without adverse effects, but it is desirable to use Mg alkoxide with a purity of 99.95% or more in terms of Mg in order to achieve PDP properties that are more suitable for practical

use.

[0020]

It is desirable to form a dielectric protective film with few impurities and preferable crystallization (i.e., few amorphisms) in order to achieve PDP properties that are more suitable for practice use. For this reason, it is preferable to use highly pure (a purity of 99.95% or more) MgO particles as seed crystals to cause crystal growth of the MgO binder.

[0021]

10 It is particularly preferable for some of the MgO particles to have been formed by a vapor phase method. MgO particles formed by a vapor phase method have properties including being highly pure and having favorable crystallization, as well as surfaces thereof being relatively smooth, and the use of MgO particles  
15 with such properties as seed particles for causing crystal growth of the MgO binder results in an MgO binder that has favorable crystallization.

[0022]

The present invention has been achieved in view of this  
20 point as well, and in a preferred embodiment of the present invention, the MgO particles are highly pure MgO particles, and furthermore, the purity of the organic acid magnesium and Mg alkoxide is high at 99.95% or more in terms of Mg. This makes it possible to have an MgO precursor paste for forming an MgO film with a low discharge  
25 initializing voltage and discharge sustaining voltage, in the case of forming dielectric protective film for a PDP.

[0023]

Moreover, from the viewpoint of making the PDP properties more suitable for practical use, it is important to consider what particle diameter of the MgO particles in the dielectric protective film obtained by baking is suitable.

5 [0024]

The present invention has been achieved in view of this point as well, and in the preferred embodiment, an average particle diameter of the MgO particles is 0.1  $\mu\text{m}$  with respect to 70 to 80 wt%, and 0.05  $\mu\text{m}$  with respect to 20 to 30 wt%.

10 [0025]

The discharge initializing voltage and discharge sustaining voltage cannot be lowered to a degree that is suited for practical use if, with respect to 100 wt% of MgO particles, more than 80 wt% have an average particle diameter of 0.1  $\mu\text{m}$ ,  
15 and less than 20 wt% are 0.05  $\mu\text{m}$ , or if less than 70% are 0.1  $\mu\text{m}$  and more than 30 wt% are 0.05  $\mu\text{m}$ . Also, it is not preferable for the diameter of the MgO particles to be 0.6  $\mu\text{m}$  or more since emission efficiency would be substantially reduced.

[0026]

20 Moreover, in the preferred embodiment of the present invention, the MgO particles and the MgO precursor are mixed to form an MgO binder that is 5 to 20 wt% inclusive with respect to 100 wt% of MgO particles.

[0027]

25 If the MgO binder is less than 5 wt% with respect to 100 wt% of MgO particles, the discharge initializing voltage and discharge sustaining voltage rise, which is not preferable for

practical use, but if the MgO binder is 5 wt% or more with respect to 100 wt% of particles, the discharge initializing voltage and discharge sustaining voltage can be lowered to a degree that is suitable for practical use.

5 [0028]

Even if the MgO binder is formed to be over 20 wt% with respect to 100 wt% of MgO particles, the effect of lowering the discharge initializing voltage and discharge sustaining voltage is almost no different from the case of forming the MgO binder to be 20 wt% or less. Furthermore, in order to obtain an MgO binder with favorable crystallization, it is not preferable to reduce the amount of particles contained in the MgO precursor per unit volume to an extreme degree since the particles function as seed crystals contributing to the crystal growth of the MgO binder. 10 It is therefore preferable to mix the MgO particles and the MgO precursor so as to form an MgO binder that is 20 wt% or less with respect to 100 wt% of MgO particles, in order to ensure that a sufficient amount of particles are contained to obtain an MgO binder with favorable crystallization. 15

20 [0029]

It is preferable for the MgO precursor paste to maintain a stable condition until application, and then harden after application and drying. The stability of an MgO precursor paste whose main component is Mg alkoxide degrades since Mg alkoxide breaks down and gelates due to moisture in the air. Stability 25 can be improved, however, by combining organic acid magnesium in a range of 2 to 95 wt% with respect to the Mg alkoxide.

[0030]

It is preferable not only for the Mg alkoxide to be simply dispersed in the MgO precursor paste, but also to be dissolved in a solvent or swollen with a solvent. It is therefore preferable  
5 for R in the general formula  $(RO)_2Mg$  for Mg alkoxide to be an alkyl, methyl, ethyl, or propyl, whereby solubility in a solvent degrades as the carbon number increase, making it difficult to form an even MgO film when used in the MgO precursor paste.

[0031]

10 There are no particular restrictions on the solvent used in the MgO precursor paste, as long as the organic acid Mg and Mg alkoxide are soluble or swellable in the solvent, and it may be any of toluene, xylene, methanol, ethanol, cyclohexanol, ethyleneglycol, 2,4-pentadione, ethyleneglycol monomethyl ether,  
15 ethylene glycol monoethyl ether, ethylene glycol monobutyl ether, diethylene-glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene-glycol monobutyl ether, acetic-acid ethylene glycol monomethyl ether, acetic-acid ethylene glycol monoethyl ether, acetic-acid ethylene glycol monobutyl ether, acetic-acid  
20 diethylene-glycol monomethyl ether, acetic-acid diethylene glycol monoethyl ether, acetic-acid diethylene-glycol monobutyl ether, terpeneol, or the like.

[0032]

While there are no particular restrictions on the  
25 manufacturing method, the MgO precursor paste can be manufactured by dissolving organic acid magnesium in a single solvent or a mixture of two or more solvents, and mixing in MgO particles,

Mg alkoxide, and ethyl cellulose as a binding agent, in a dispersion device such as roll mill, sand mill, or homogenizer. The type and amounts of the solvents and thickening agent such as ethyl cellulose can be changed as necessary.

5 [0033]

In the manufacturing method for the MgO precursor paste, in which MgO particles are diffused in a solvent, an organic acid is added and reacts with the MgO to form a paste composed of MgO particles, organic acid magnesium and solvent, Mg alkoxide and  
10 a thickening agent such as ethyl cellulose are added, and the mixture is diffused using an appropriate one of a diffusion methods such as a roll mill, a sand mill, or a homogenizer, the amount of MgO with respect to the organic acid is in excess according to theoretical chemistry. In other words, it becomes possible  
15 for 1.4 moles of MgO to react for 1 mole of organic acid. Therefore, given that it is possible to reduce the organic acid by 40% compared to using ordinary organic acid magnesium if the MgO precursor paste is manufactured using this method, the MgO film obtained by application thermal decomposition is precise and preferable  
20 as an MgO precursor.

[0034]

[WORKING EXAMPLE]

Although the superiority of the present invention is described below according to a working example, the present  
25 invention is not limited to this. Note that compound ratios in the tables depend on weight.



### *Working Example 1*

Pastes were made using a three roll mill and a reagent (purity of 98%) as the MgO particles, Mg ethyl oxide (reagent) and an organic acid magnesium as the MgO precursor, butyl carbitol  
5 as the solvent, and ethyl cellulose as the thickening agent, in the compound ratios shown in Table 1. An applicator with a thickness of 50  $\mu$ m and a width of 8 mm was used to apply the pastes to soda lime glass with a width of 15 mm and a thickness of 1.5 mm, and the paste was dried for 15 minutes at 150 °C. Thereafter,  
10 the pastes and soda lime glass were placed in an electric furnace, the temperature was raised to 550 °C in increments of 10 °C per 1 minute, the 550 °C temperature was maintained for 10 minutes, and then cooling was performed. After investigating the hardness of the MgO films formed after cooling, all were favorable as shown  
15 in Table 1, but upon leaving the pastes for two days in a 25 °C oven where the atmosphere at 75% relative humidity, No.6 (comparative example), whose MgO precursor was Mg ethoxide gelated. Although no rise in thickening was perceived for No.7 (comparative  
example) which contains a small amount of Mg ethoxide, the MgO  
20 film that formed was too soft, and could be easily wiped away.

[0035]

Table 1

Material \ No.		1	2	3	4	5	6 Comparative Example	7 Comparative Example
Compound Ratio	Organic acid Mg	95	50	2	50	50	0	98
	Mg ethoxide	5	50	98	50	50	100	2
Mg ethoxide (contains 20.8% Mg)		0.5	4.8	9.2	5.0	5.0	9.4	.02
Octylic acid Mg (contains 7% Mg)		26.5	14.0	0.6	-	-	-	27.4
Versatic acid Mg (contains 4% Mg)		-	-	-	24.4	-	-	-
Naphthenic acid Mg (contains 3% Mg)		-	-	-	-	32.6	-	-
MgO (0.1 $\mu$ )		23.2	23.2	23.2	23.2	23.2	23.2	23.2
Butyl carbitol		102.0	102.0	132.0	102.2	102.0	150.0	150.0
Ethyl cellulose		10.0	7.0	5.0	10.0	10.0	10.0	10.0
(Total)		162.2	151.0	170.0	164.6	172.8	192.5	162.2
Result	Hardness of MgO film (Note 1)	○	○	○	○	○	○	×
	Stability of paste (Note 2)	○	○	○	○	○	×	○

(Note 1) Hardness of MgO film: examined whether the MgO film was damaged when rubbed with a finger

Evaluation: ○ (favorable), △ (MgO adhered to finger),  
× (MgO film was damaged)

(Note 2) Stability of paste: examined viscosity after leaving for 30 days in an oven at 25 °C with an atmosphere at 75% relative humidity

[0036] Working Example 2

5 Pastes were made using a three roll mill and ultrafine MgO particles (purity of 99.98%) obtained by a vapor phase method as the MgO particles, octylic acid Mg (purity of MgO was 99.99%) and Mg ethoxide (purity of MgO was 99.99%) as the MgO precursor,

butyl carbitol as the solvent, and ethyl cellulose as the thickening agent, in the compound ratios shown in Table 2.

[0037]

Fig.1 is a schematic perspective view of a structure of an AC-PDP manufactured using the paste of working example 2. An AC-PDP 10 in Fig.1 is a surface-discharge PDP, and display electrodes 14, a dielectric material 16, and a dielectric protective film 18 are formed sequentially on a back plate 12 of the PDP 10. The display electrodes 14 are Au thick films formed using an Au paste (Engelhard, A-3725), the dielectric material 16 is a dielectric thick film formed using a dielectric paste (Okuno Chemical Industries, G3-0496), and the dielectric protective film 18 is an MgO film formed using the paste of working example 2.

[0038]

A phosphor layer 22 and barriers (not depicted) are also sequentially formed on a front plate 20 of the PDP 10. The phosphor 22 is a green phosphor layer formed using a phosphor paste containing  $\text{Zn}_2\text{SiO}_4\text{:Mn}$  (Kasei Optonics, P1-G1), and the barriers are formed using a glass paste (Dupont, 9741).

[0039]

Table 2 shows results of experimentally investigating panel properties such as discharge initializing voltage  $V_f$  [V], discharge sustaining voltage  $V_s$  [V], luminance [ $\text{cd/m}^2$ ], discharge sustaining current per cell [ $\mu\text{A/cell}$ ], and emission efficiency [ $\text{lm/W}$ ] upon filling a He-5%Xe gas, as a discharge gas, at 500 Torr into a discharge space 24 between the back plate 12 and the

front plate 20, and driving the PDP 10 at 20 KHz.

[0040]

Table 2

No.		8	9	10	11	12	13
Compound	Mg ethoxide (contains 20.8% Mg)	1.0	1.0	1.0	1.0	1.0	1.0
	Octylic acid Mg (contains 7% Mg)	25.0	25.0	25.0	25.0	25.0	25.0
	MgO (0.1 $\mu$ m)	23.2	14.0	16.3	18.0	21.0	-
	Mg (0.05 $\mu$ m)	-	9.2	6.9	5.2	2.2	23.2
	Butyl carbitol	102.0	102.0	102.0	102.0	102.0	102.0
	Ethyl cellulose	10.0	10.0	10.0	10.0	10.0	10.0
	(Total)	161.2	161.2	161.2	161.2	161.2	161.2
Experiment Result	Discharge initializing voltage Vf [V]	293	279	246	250	283	285
	Discharge sustaining voltage Vs [V]	267	263	225	228	265	271
	Discharge sustaining current [ $\mu$ A/cell]	9.33	8.87	8.89	8.90	8.93	9.20
	Emission efficiency [lm/W]	1.277	1.330	1.606	1.524	1.322	10297
	Luminance [ $\text{cd/m}^2$ ]	1013	990	1023	985	996	1030

5

[0041]

As can be seen in Table 2, the average value of the discharge initializing voltages Vf [V] of Nos.10 and 11 is 41 V lower than the average value of Nos.8 and 13, and the average value of the discharge sustaining voltages Vs [V] of Nos.10 and 11 is 42 V less than the average value of Nos.8 and 13. For this reason, the luminance efficiencies [lm/W] of Nos.10 and 11 are 1.2 times those of Nos.8 and 13. The ability to increase brightness with a low voltage is very preferable function of the PDP protective film.

[0042] *Working Example 3*

Pastes were made in the same way as in working example 2, but using the compound ratios of Nos.14 and 15 in Table 3. The experiment concerning panel properties was carried out using the same method as in working example 2. The results of this experiment are shown in Table 3.

[0043]

*Table 3*

No.		14	15
Conditions	Purity of Mg in terms of Mg (Note 1)	99.95% or more	99.0%
	Average particle diameter of MgO particles	0.1 $\mu\text{m}$	0.1 $\mu\text{m}$
Compound	Mg ethoxide (contains 20.8% Mg)	1.0	1.0
	Octylic acid Mg (contains 7% Mg)	25.0	25.0
	MgO	23.2	-
	Mg (commercial)	-	23.2
	Butyl carbitol	102.0	102.0
	Ethyl cellulose	10.0	10.0
	(Total)	161.2	161.2
Experiment Result	Discharge initializing voltage $V_f$ [V]	286	340
	Discharge sustaining voltage $V_s$ [V]	275	297
	Discharge sustaining current [ $\mu\text{A}/\text{cell}$ ]	8.89	20.56
	Emission efficiency [ $\text{lm}/\text{W}$ ]	1.301	0.523
	Luminance [ $\text{cd}/\text{m}^2$ ]	1013	1018

(Note 1) Purity of Mg included in Mg ethoxide and organic acid Mg

As can be seen in Table 3, when the purity of the MgO formed from the MgO used in the paste and the octylic acid Mg is high (99.95% or more in terms of Mg), that is to say, compared to NO.15, the discharge initializing voltage  $V_f$  [V], discharge  
5 sustaining voltage  $V_s$  [V], and discharge sustaining current [ $\mu A/cell$ ] of No.14 is substantially lower, emission efficiency is substantially improved.

[0045]

#### [EFFECTS OF THE INVENTION]

10 In a dielectric protective film formation paste composed of MgO particles, an MgO precursor which forms an MgO binder when fired and an additive composed of organic substances, although it is possible to obtain a paste that resists gelation if only an organic acid magnesium is used as the MgO precursor in the  
15 present invention, the dielectric protective film formed by application thermal decomposition of the paste will be too soft due to the effect of the organic material dissipating during vaporization or thermal decomposition, whereby a slight force will easily cause damage. On the other hand, if only Mg alkoxide  
20 is used as the MgO precursor, gelation will readily occur due to hydrolysis, and handling will be limited, but application thermal decomposition will form an MgO film that is hard and has physical strength.

[0046]

25 The present invention enables providing a dielectric protective film formation paste that can be handled easily and can form a strong MgO film, by using a combination of an organic

acid magnesium that forms an MgO film which resists gelation but lacks strength, and Mg alkoxide that forms an MgO film which is hard but readily gelates and is difficult to handle.

[0047]

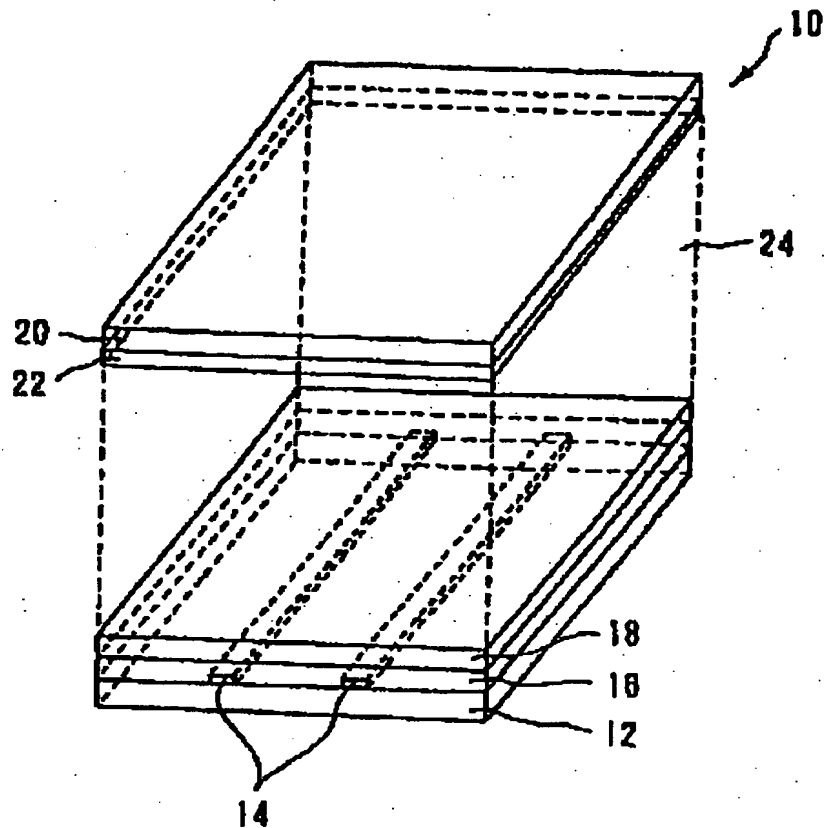
5       Also, by using the organic acid Mg and Mg alkoxide including highly pure Mg as the Mg precursor, and further using MgO particles that are highly pure and have different particle diameters, it is possible to form an MgO film with a low discharge initializing voltage and discharge sustaining voltage and more suitable for  
10 practical use when used as a dielectric protective film in a PDP.

#### [BRIEF DESCRIPTION OF THE DRAWINGS]

Fig.1 is schematic view of a structure of an AC-PDP manufactured using the paste of working example 2.

15

FIG. 1



- |                        |                          |
|------------------------|--------------------------|
| 10 : AC - PDP          | 12 : BACK PLATE          |
| 14 : DISPLAY ELECTRODE | 16 : DIELECTRIC MATERIAL |
| 18 : PROTECTIVE FILM   | 20 : FRONT PLATE         |
| 22 : PHOSPHOR LAYER    | 24 : DISCHARGE SPACE     |